DATA HOLDING SYSTEM OF SEMICONDUCTOR FILE

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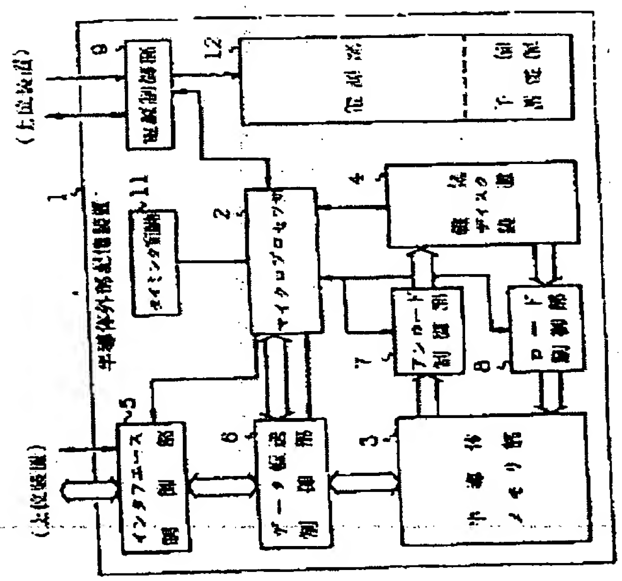
Abstract of **JP60045857**

PURPOSE:To handle almost equally with the file of a nonvolatile memory element by providing a function to said volatile file to save all data by single device itself.
CONSTITUTION:When the drop-out of the power supply of a system is detected, a microprocessor 2 actuates the reading circuit of a semiconductor memory part 3 of an unloading control part 7 by an unloading interruption indication to prepare for reading. At the same time, a magnetic disk device 4 performs positioning to an index. The first sector ID part (track and sector number) is read out of the part 3, and its normalcy is confirmed. Then a sector component of a disk is read out and then written. The same action is repeated until the final track, and the data within the memory 3 are divided into each fixed sector data length of the disk to read out all data of the memory 3. A flag is written to the control sector part of the disk to secure that the data is unloaded correctly on the disk. Then the power supply is cut off. In the case of a service interruption, the working is maintained with use of a spare accumulator part.



SPECIFICATION

1. Title of the Invention: DATA HOLDING SYSTEM OF SEMICONDUCTOR FILE

2. What is claimed is:

(1) A data holding system of a semiconductor file comprising:

a volatile memory formed by semiconductor memory elements;

a nonvolatile memory with a capacity equal to or larger than said volatile memory;

a circuit for controlling data transfer between said nonvolatile memory and said volatile memory;

a circuit for controlling an interface with an upper system; and

means for detecting states of a power supply part of said upper system, saving all data stored in said volatile memory to said nonvolatile memory, determining a time point when restoring data, and controlling write/read operations.

(2) The data holding system of semiconductor file according to Claim 1, wherein said means of write/read control, when saving or restoring data, performs conversion between the volatile memory's format for interface with the upper system and the nonvolatile memory's physical format and writes data in sectors.

(3) The data holding system of semiconductor file according to Claim 1, wherein said means of write/read control, when saving

or restoring data, writes/reads data using the volatile memory's format for interface with the upper system without changing the format, and writes data in spiral fashion on a nonvolatile memory.

3. Detailed Description of the Invention

[Field of the Invention]

The present invention relates to a data holding system of semiconductor files, and more specifically to a method of saving or restoring data of a semiconductor file, which enables high-speed access and provides volatility measures.

[Background of the Invention]

As recording media for external memory devices (hereafter referred to as files), memory media have been used, such as magnetic disks, magnetic drums, and magnetic tapes. Those memory media require access time, including rotational delay time and seek time, which is five orders of magnitude longer than that of the main memory composed of semiconductor memories. How to reduce access gap between disk device speed and CPU speed has been a problem. To this end, the use of random-access type semiconductor memory elements as a recording medium was started by way of trial but has been gradually made possible to respond to increasing demand for high-speed access to files, spurred on by rapid capacity increases and price reductions of semiconductor memory elements.

However, the semiconductor memory element has a shortcoming that stored data evaporate when power failure occurs, and as a countermeasure for such a disaster, various kinds of data holding method have been created.

The data holding system of a conventional volatile file is such that when a power failure occurs, a command is issued by the central processing unit to store part of the contents in the data-volatile file is saved to a nonvolatile memory.

Fig. 1 is a diagram for explaining the data holding system of a conventional volatile file. In Fig. 1, numeral 1 denotes a central processing unit (hereafter referred to as a CPU), 20 and 21 denote channel devices (CHL), 30 and 31 denote file controllers (IOC), 40 denotes a data-volatile file, and 41 denotes a data-nonvolatile file.

Generally, the contents of the data-volatile file 40 are read in control units by a system program for backup, the read contents, after once fetched into the CPU 10 through the file controller 30 and the channel device 20, are written into the data-nonvolatile file 41 for holding data through the other channel device 21 and the other file controller 31.

However, the system shown in Fig. 1 has a drawback that a system-based overhead increases as the capacity of the file 40 increases because many devices and paths are used when saving data.

Though there are inventions which save data on the volatile memory part to the nonvolatile memory part when power supply stoppage occurs (Refer to JP-A-49-24050 and JP-A-55-4651), both of them do nothing more than save a minimum amount of data necessary for restarting the operation, much less save all data, with the result that the lost amount of latest data is very large, indeed. And in these inventions, data is saved solely by commands from the CPU, but data cannot be saved by an independent judgment of the volatile file by itself. Therefore, it is impossible to adopt a system which, when communication with the CPU terminates, saves latest data and holds as much updated data as possible.

[Object of the Invention]

The object of the present invention is to provide a data holding system of a semiconductor file, which solves the above-mentioned problem and furnishes a file, made up of volatile memory elements, with a function of saving all data by the file device by itself, so that this volatile file can be handled almost simultaneously with handling of a nonvolatile file.

[Summary of the Invention]

A data holding system of a semiconductor file comprises a volatile memory formed by semiconductor memory elements; a nonvolatile memory with a capacity equal to or larger than said

volatile memory; a circuit for controlling data transfer between said nonvolatile memory and said volatile memory; a circuit for controlling an interface with an upper system; and means for detecting states of a power supply part of said upper system, saving all data stored in said volatile memory to said nonvolatile memory, determining a time point when restoring data, and controlling write/read operations.

[Embodiment of the Invention]

Fig. 2 is an interior block diagram of a semiconductor file showing an embodiment of the present invention.

In Fig. 2, numeral 1 denotes a semiconductor file, 2 denotes a microprocessor to manage a semiconductor file, 3 denotes a semiconductor memory part to store user data, 5 denotes a controller of an interface to connect to an upper control system, 6 denotes a controller of data transfer with the upper system, 7 denotes an unloading controller for controlling saving of data on the semiconductor memory part 3 to a magnetic disk 4, 8 denotes a loading controller for controlling recovery of data to the memory in a reverse direction to saving data, 9 denotes a power supply controller, 12 denotes a power supply part with a spare accumulator part for supplying electric power to the whole of the file, and 11 denotes a timing circuit. A single line with an arrow mark indicates a control signal line, a bold line with an arrow mark indicates a data line, and a wavy line with an

arrow mark indicates a power supply line. The semiconductor memory part 3 is composed of a plurality of file volumes, and each volume is divided logically by soft interface used by the upper system. For example, one volume may be divided into a number of memory areas so as to correspond to the tracks of a magnetic disk. The magnetic disk device 4 has a capacity equal to or greater than the semiconductor memory part 3. Each track is divided into N pieces of fixed-length sectors, and each sector is composed of an ID section (position identification information section), a data section, and a gap.

As an example of the present invention, referring to Fig. 3, description will be made of a control sequence in a case when a start point of data saving (unloading) operation is when system power supply fails. In this figure, the process to be performed upon occurrence of an abnormal condition is omitted.

When the power supply for the system stops, on detecting the power failure, the power supply controller 9 sends an interrupt for start of loading to the microprocessor 2 (Steps 51, 52). Upon occurrence of this interrupt, the microprocessor 2 supplies power to the magnetic disk device 4, waits until steady-state rotation is reached, the read/write head is positioned to cylinder number 0 and track number 0 by a rezero operation (Steps 53, 54, 55). The microprocessor 2 activates the read circuit of the semiconductor memory part 3 in the

unloading controller 7 to get ready for reading data starting with the start address of memory and; on the other hand, in the magnetic disk device 4, the read/write head is positioned to the index (Steps 56, 57). After positioning to the index, the ID section of the initial sector is first read, by which the normalcy of that ID section is confirmed (Steps 58, 59). After the normalcy of the sector is confirmed, data in the semiconductor memory part 3 is read in an amount corresponding to one sector (fixed length) of the magnetic disk and written in the data section of the sector on the disk 4 (Step 60). This operation is repeated on the N sectors in one track as the magnetic disk 4 rotates, and as the track is switched to the next track, the same operation is repeated (Steps 62, 63, 64). When the operation is finished on the final track in a cylinder of the magnetic disk 4, instead of switching to the next track, a seek action takes place to the next cylinder (Steps 63, 65). The above-mentioned operation of dividing data on the memory into fixed sector data lengths of the magnetic disk and unloading the data sequentially is repeated until all data of the semiconductor memory part 3 have been read, and when all data have been read, the memory read circuit in the unloading controller 7 is deactivated (Steps 61, 66). Thus, the user data stored in the semiconductor memory part 3 have all been saved in the magnetic disk device 4. Then, an unloading completed

flag guaranteeing that correctly unloaded data existing on he disk is written in the control sector portion on the magnetic disk device 4 (Step 67). Consequently, the operation on the magnetic disk 4 is not required any more; therefore, the power supply is cut off (Step 68). The microprocessor 2 sends an unloading completed signal to the power supply controller 9, and the power supply controller 9 reports cut-off of power supply to the upper system and at the same time cuts off the power supply to the whole of the device 1 (Steps 69, 70). Thus, the unloading sequence has been completed. Note that if this power stoppage is due to power service interruption, the power supply controller 9 makes use of power from the spare accumulator in the power supply part 12 to carry on the above-mentioned operation.

The characteristic point of this sequence is that it is possible to divide the memory according to the physical format of the magnetic disk as a saving medium and save data without being conscious of the data format of the semiconductor memory part 3.

Fig. 4 is a diagram for explaining the format of the semiconductor memory part and the track format of the built-in magnetic disk.

As shown in Fig. 4(a), the semiconductor memory part 3, when used by the upper system, is divided in a variable length

format (soft interface format) composed of a HA section, a count section, a key section, a data section or the like. When unloading data, as shown in Fig. 4(b), the memory part 3 is divided equally into fixed sector lengths of the built-in magnetic disk (disk interface format) and data in disk interface format from the memory is written sequentially on the disk. This unloading operation is finished when all sector-divided data of the memory part 3 have been written on the disk.

In Fig. 4(a), the position of a track is stored in the HA (Home Address) section, the position of a record (indicating what number the record is), and the record length (because the record length is variable) are stored. The key section stores information by which for the user to search user data by the key data. A plurality of records (counter and data sections) are stored successively in one HA section, but a key section is provided at positions where necessity requires.

As shown in Fig. 4(b), data of the semiconductor memory part 3 is divided to correspond to the fixed sector data sections of the magnetic disk, and as shown in Figs. 4(c) and 4(d), divided data are written in the data sections of sectors #0 to #(N-1) which continue after an index on each track. The ID section stores a track number and a sector number, or the like.

Fig. 5 is a flowchart of data recovery operation.

The loading sequence is started when the system power supply

is turned on, and is almost the same as in the unloading operation excepting only that the flow of data at this time is from the magnetic disk 4 to the semiconductor memory part 3.

However, the difference is that an unloading completed flag of 1 is used as the start condition of loading.

When the upper system notifies power supply ON to the power supply controller 9, the power supply controller 9 sends an interrupt for start of loading to the microprocessor 2 (Steps 71, 72). The microprocessor 2 turns on power supply to the magnetic disk device 4, and when the motor reaches a steady rotation, reads an unloading completed flag from the control sector part on the disk, and by detecting that the flag is "1", the microprocessor 2 decides that semiconductor-file data has been saved securely, and starts loading data (Steps 73, 74, 75). After positioning the read/write head to the track on the initial cylinder, the microprocessor 2 activates the semiconductor-memory write circuit in the loading controller 8 to get ready for writing on the memory part 3 (Steps 76, 77). Then, the read/write head is positioned to an index of the magnetic disk, the ID section is first read and data in an amount of one sector is read and written on the semiconductor memory part 3 (Steps 78 to 81). This operation is repeated for one sector after another, and when the final sector of the track is finished, the track is switched to the next track, and when

the final track of the cylinder is finished, a seek is made to the next (Steps 83 to 86).

When all data has been loaded, the memory write circuit in the loading controller 8 is deactivated, then the power supply to the magnetic disk device 4 is cut off and a loading completed signal is sent to the power supply controller 9 (Steps 82, 87 to 89).

On receiving a signal of loading completion from the power supply controller 9, the upper system recognizes that it is possible to access files, and makes an access to data as the need arises.

Incidentally, in an embodiment shown in Fig. 4, the formats are changed to perform loading and unloading; however, if data can be saved to the disk without changing the format of the semiconductor memory, loading and unloading operations can be performed at high speed.

Description will now be made of a method of writing on a magnetic disk, which enables the above-described saving operation.

Fig. 1 is a diagram showing a method of writing in spiral form on a magnetic disk.

As an inexpensive large-capacity memory device for storing vast amounts of data, a magnetic disk device on which data is written serially has been put into practical use. This magnetic

disk, because data is written serially in spiral form, assures high-speed writing and high-speed access. As shown in Fig. 6, information is recorded in spiral form on a circular disk 15 while the read/write head is displaced little by little continuously traveling along a data track 13. Note, however, that unlike with an ordinary sector-pattern magnetic disk on which data is recorded on a plurality of concentric tracks, in this device, rewriting directly results in destruction of data; therefore, a protective means needs to be provided for this device.

Consequently, as shown in Fig. 7, an ECC section is added to each of the ID section and the data section (DATA), and gap sections G to absorb rotation fluctuations are also provided. However, provided that ECC sections are added, the format of a semiconductor memory part shown in Fig. 4(a) may be used. If the magnetic disk is created in the same format as the semiconductor memory part as shown in Fig. 4(a), it becomes unnecessary to change the formats when saving or recovering data. In recording on this disk, the head is displaced in a spiral form and travels only from the outside to the inside of the disk, so that control is simple and data can be transferred at high speed.

It is of course possible to convert the format and rewrite in sectors.

[Effect of the Invention]

As has been described, according to the present invention, a magnetic disk may be used for the built-in nonvolatile memory.

Moreover, loading and unloading may be started by a command from the upper system. An optical disk device may also be used.

In the embodiment, description has been made of a case where data is saved when system power supply is cut off; however, because, in the present invention, data can be saved based on an independent decision of the file device, it is possible to save data at various points in time. For example, while the CPU operation is monitored for a fixed period of time by the file device, if communication from the CPU is cut off, by saving all data, latest data updated by the CPU can be stored in the disk. Also, when the work of the system is closed, all data can be saved in the disk by a command from the CPU.

4. Brief Description of the Drawings

Fig. 1 is a diagram showing a data holding system of a conventional volatile file.

Fig. 2 is an interior block diagram of a semiconductor file showing an embodiment of the present invention.

Fig. 3 is a flowchart of a data saving operation in Fig. 2.

Fig. 4 is a diagram showing conversion between the format of the semiconductor memory part and the track format of the

magnetic disk.

Fig. 5 is a flowchart of the data recovery operation in Fig. 2.

Fig. 6 is a diagram showing a method of spiral data writing of the disk.

Fig. 7 is a format diagram of the disk shown in Fig. 6.

1 ... Semiconductor file

2 ... Microprocessor

3 ... Semiconductor memory part

4 ... Magnetic disk device

5 ... Interface controller

6 ... Data transfer controller

7 ... Unloading controller

8 ... Loading controller

9 ... Power supply controller

10 ... Power supply part

11 ... Timing circuit

図面の訳

FIG. 1

40. DATA-VOLATILE EXTERNAL MEMORY DEVICE

41. DATA-NONVOLATILE EXTERNAL MEMORY DEVICE

FIG. 2

1. SEMICONDUCTOR EXTERNAL MEMORY DEVICE

2. MICROPROCESSOR

3. SEMICONDUCTOR MEMORY PART

4. MAGNETIC DISK DEVICEE

5. INTERFACE CONTROLLER

6. DATA TRANSFER CONTROLLER

7. UNLOADING CONTROLER

8. LOADING CONTROLLER

9. POWER SUPPLY CONTROLLER

11. TIMING CIRCUIT

12. POWER SUPPLY PART 予備蓄電部 SPARE ACCUMULATOR PART

上位装置 UPPER SYSTEM

FIG. 3

51. DETECT POWER FAILURE OF POWER SUPPLY CONTROLLER 9

52. INTERRUPT FOR START OF LOADING FROM POWER SUPPLY CONTROLLER 9 TO MICROPROCESSOR 2

53. SUPPLY POWER TO MAGNETIC DISK DEVICE 4

54. STEADY ROTATION

55. MAGNETIC DISK: POSITION HEAD TO INITIAL CYLINDER AND TRACK

56. GET READY FOR READING ON SEMICONDUCTOR MEMORY 3

57. MAGNETIC DISK: POSITION HEAD TO INDEX

58. MAGNETIC DISK: POSITION HEAD TO SECTOR

59. CONFIRM READING OF ID SECTION

60. WRITE IN DATA SECTION

61. UNLOADING OF WHILE MEMORY PART COMPLETED?

62. IS THIS THE FINAL SECTOR OF TRACK?

63. IS THIS THE FINAL TRACK IN CYLINDER?

64. SWITCH TO NEXT TRACK

65. SEEK TO NEXT CYLINDER

66. STOP READING ON SEMICONDUCTOR MEMROY 3

67. MAGNETIC DISK: POSITION HEAD TO AND WRITE UNLOADING COMPLETION FLAG

68. CUT OFF POWER SUPPLY TO MAGNETIC DISK DEVICE 4

69. MICROPROCESSOR 2 NOTIFIES UNLOADING COMPLETION TO POWER SUPPLY CONTROLLER 9

70. POWER SUPPLY CONTROLLER 9 REPORTS POWER CUT-OFF TO UPPER SYSTEM AND CUT OFF POWER TO SYSTEM 1

FIG. 4

101. HA SEC. 102. COUNT SEC. 103. KEY SEC. 104. DATA SEC.

105. COUNT SEC. 106. DATA SEC. 107. COUNT SEC. 108. DATA SEC.

109. REMAINDER

110. FIXED SEC. DATA SEC. 111. SAME AS IN LEFT

112. SECTOR #0 113. SECTOR #(N-1)

114. INDEX 115. ID SEC. 116. DATA SEC.

FIG. 5

71. NOTIFY POWER-ON TO POWER SUPPLY CONTROLLER 9

72. INTERRUPT FOR START OF LOADING FROM POWER SUPPLY CONTROLLER 9 TO MICROPROCESSOR 3 (直訳) → (2が正しい)

73. SUPPLY POWER TO MAGNETIC DISK DEVICE 4

74. STEADY ROTATION

75. READ UNLOADING COMPLETED FLAG

76. MAGNETIC DISK: POSITION HEAD TO INITIAL CYLINDER, TRACK

77. GET READY FOR WRITING ON SEMICONDUCTOR MEMORY PART 3

78. MAGNETIC DISK: POSITION HEAD TO INDEX

79. MAGNETIC DISK: POSITION HEAD TO SECTOR

80. CONFIRM READING OF ID SECTION

81. READ DATA SECTION

82. LOADING OF WHOLE MEMORY PART COMPLETED?

83. IS THIS THE FINAL SECTOR OF TRACK?

84. IS THIS THE FINAL TRACK IN CYLINDER?

85. SWITCH TO NEXT TRACK

86. SEEK TO NEXT CYLINDER

87. STOP WRITING ON SEMICONDUCTOR MEMROY 3

88. CUT OFF POWER SUPPLY TO MAGNETIC DISK DEVICE 4

89. MICROPROCESSOR 2 NOTIFIES LOADING COMPLETION TO POWER SUPPLY CONTROLLER 9